ARTICLE

# Simulating Synesthesia in Spatially-Based Real-time Audio-Visual Performance

by

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### TECHNICAL INTRODUCTION

**Using the tracking capabilities of the Gesture and Media System (GAMS) - invented by APR of Edmonton, Canada -** artists can 'map' an interactive space with sound, light and images, and have user-movement dynamically control these elements via small 3D trackers. With GAMS one is immersed in a system where the displacement of a body in space triggers and manipulates events in a digital environment. The user carries a small infrared tracker through a room bounded by four cameras. Up to sixteen trackers can be used simultaneously. The infrared tracker emits light that the cameras can pick out against most other indoor light sources. The tracker then calculates where the user is standing in relation to centre of the room. As the user moves through the room coordinates are sent to a PC. The PC receives the coordinates, and passes them to custom-designed software called FlashTrack. The software allows for simultaneously control of protocols such as MIDI (for music and video), DMX512 (for lighting), and serial or UDP data output (for programming and network-based interaction). The software can be configured so that audio, video and lighting effects can be 'located' at specific co-ordinates in the room. GAMS is ideal for motion-

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ABSTRACT

*In this paper I will describe and present examples of my live audio-visual work for 3D spatial environments. These projects use motion-tracking technology to enable users to interact with sound, light and video using their body movements in 3D space. Specific video examples of one past project* (Virtual DJ) *and one current project* (Virtual VJ) *will be shown to illustrate how flexible user interaction is enabled through a complex and precise mapping of 3D space to media control. In these projects audience members can interact with sound, light and video in real-time by simply moving around in space with a tracker in hand. Changes in sound can be synchronized with changes in light and/or real-time visual effects (i.e. music volume = light brightness = video opacity). These changes can be dynamically mapped in real-time to allow the user to consolidate the roles of DJ, VJ and light designer in one interface. This interaction model attempts to reproduce the effect of synesthesia, in which certain people experience light or color in response to music.*

based installation as it easy to configure, it can allow for control of multiple media elements simultaneously and it allows for multiple participants to interact with the same environment. Due to its ability to control media concurrently GAMS is also an ideal technology for 'synesthetic' environments in which multiple senses are activated at the same time.

**SYNESTHESIA**

Synesthesia is a condition that allows a person to experience sensations from one sense in a second different sense. One of the most common synesthetic occurrences is a description of color related to musical tones. "How does it feel to hear music in color, or to see someone's name in color? These are examples of synesthesia, a neurological phenomenon that occurs when a stimulus in one sense modality immediately evokes a sensation in another sense modality. Literally, 'synesthesia' means to perceive (*esthesia*) together (*syn*)." [1] There exist multiple types of synesthetic experience, as outlined on the Mixed Signals's website: ".... synesthesia comes in a many varieties. When a person thinks of mixed senses, what generally comes to mind is the mixing of sight and sound, taste and touch, or maybe smell and sound. If only the five senses — sight, smell, sound, taste, and touch — were considered to be 'mixable' synesthetically, there would theoretically be 20 different forms of synesthesia...." [2]

As synesthesia is a neurological condition based on subjective experience of sensory input it is difficult to verify the exact claims made for its occurrence. However, there is a strong enough body of qualitative evidence based on recent neurological analysis to conclude that the condition is real for about 5% of the population: "Synesthetes rarely talk about their peculiar sensory gifts—believing either that everyone else senses the world exactly as they do, or that no one else does. Yet synesthesia occurs in one in twenty people, and is even more common among artists." [3] In addition with the development of more refined brain scans there is compelling scientific evidence that synesthetes can experience the sensation of one sense in response to stimulus from another sense: "In one test, a synesthetic person was blindfolded and placed in a recording tunnel of the brain-scanning apparatus and wore headphones that produced spoken words at regular intervals.... The brain scan taken from the right side of the head of a blindfolded synesthete shows activity in the color center of the brain at the back of the head... when she hears words. This activity is absent in nonsynesthetes." [4]

| Note | Colour |
|---|---|
| C | red (intense) |
| C# | violet or purple |
| D | yellow |
| D# | flesh (glint of steel) |
| E | sky blue (moonshine or frost) |
| F | deep red |
| F# | bright blue or violet |
| G | orange |
| G# | violet or liliac |
| A | green |
| A# | rose or steel |
| B | blue or pearly blue |

**Figure 1.** Notes to colors on Scriabin's color organ.

## SYNESTHESIA AND THE ARTS

> *When discussing synesthesia in art, a distinction needs to be made between two possible meanings:*
>
> *1. Art by synesthetes, in which they draw on their personal synesthetic perceptions to create works of art.*
> *2. Art that is meant to evoke synesthetic associations in a general (mainly non-synesthetic) audience.* [5]

For this paper I will primarily focus on the second option described above, referring specifically to works of art that seek to simulate the effects of synesthesia. There are a several examples of synesthetic simulation in the arts of the past two centuries. Devices such as the color organ (sometimes later referred to as the light organ) have a history dating back until the 18th century, with working models patented as far back as the 1890s: "The British inventor Alexander Wallace Rimington (1854-1918), a professor of arts in London was the first to use the phrase 'Colour Organ,' in his patent application of 1893. Inspired by Newton's idea that music and color are both grounded in vibrations, he divided the color spectrum into intervals analogous to musical octaves and attributed colors to notes." [6] It should be noted that Rimington's 'Colour Organ' did not produce any sound by instead was meant to be played alongside an organ which played the musical side of the synesthetic performance. Multiple versions of a color organ that could play both light and sound simultaneously were produced in the early 20th century, most notably the 'Farbenlichtspiel' color organ created by Ludwig Hirschfeld Mack and Kurt Schwerdtfeger at the Weimar Bauhaus in 1923-24. [7]

The idea of simultaneously performed sound and visuals was a notion that influenced a wide variety of artists and musicians in the early modernist period. For example the Russian composer Alexander Scriabin (1872-1915) "was influenced by synesthesia, and associated colors with the various harmonic tones of his atonal scale." [8] Scriabin was a self-described synesthete who claimed he experienced certain colors in response to the twelve tonalities of Western music. [9] His idea for the color organ was that certain colors would be activated in response to specific tonalities, as shown in Figure 1. [10] Scriabin famously composed his *Prometheus, Poem of Fire* (1911) using a device

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called a 'chromola' invented by Preston S. Millar. "In Scriabin's system, the color changed only if the tonality or key of the music changed. In this way Scriabin prevented the beholders from being overwhelmed by a bombardment of colors, as happened in performances by Rimington, where every played note was accompanied by a color." [11] The initial performance of this piece was hampered by the unreliability of the 'chromola.' Later attempts to update the light part of the work have proven tricky as well: "... there have been different performance attempts which reflected the possibilities of lighting technology of the corresponding periods. However, whether spotlights and color filters, neon tubes or, just recently, sophisticated LED technology were used, an optimal transformation of Scriabin's visions seems difficult to realize." [12] Despite the above, Scriabin's core idea of a matched system of music tonality to light color was an intriguing concept, and was arguably farther-reaching and more influential than that of Rimington's more basic light organ.

Later experiments in synesthetic combination of sound and visuals expanded the notion to include sound combined with more complex visual experiences, including moving pictures. Early examples of this include Oskar Fischinger's animations which "explored the double identity of the optical film soundtrack, printing regular visual patterns into the 3mm-wide sound strip at the edge of the frame, enabling them to be automatically rendered as sound." [13] His project *Sounding Ornaments* (1932) is the first example of this striking use of drawn sound: "If you look at a strip of film from my experiments with synthetic sound, you will see along one edge a thin stripe of jagged ornamental patterns. These ornaments are drawn music -- they are sound: when run through a projector, these graphic sounds broadcast tones or a hitherto unheard of purity, and thus, quite obviously, fantastic possibilities open up for the composition of music in the future." [14]

The Scottish-Canadian animator Norman McLaren later perfected Fischinger's techniques in a series of works using drawn-soundtracks: "The later work of animator Norman McLaren developed Fischinger's techniques, synchronising hand-drawn optical soundtracks with animation in *Dots* (1940), and finally using the synthesised optical soundtrack as synchronised visual source material in *Synchromy* (1971)." [15] Len Lye also expanded on Fischinger's technique updating it to include "a method of painting and staining directly on celluloid.... Films such as *A Colour Box* (1935), *Rainbow Dance* (1936), *Trade Tattoo* (1937) and *Swinging the Lambeth Walk* (1939) include rapid-fire nervous imagery... intricately synchronized not to classical music but to jazz and Latin rhythms." [16] Lye's works are interesting for our discussion as they synesthetically blend visual abstraction with popular music forms. This combination is also evident in my works, *Virtual DJ* and *Virtual VJ,* discussed below.

Later artists continued the conceptual ideas of Fischinger, McLaren and Lye, translating these from animation into filmed and computer-generated experiences. Most notable among these were Stan Brakhage who continued McLaren and Lye's hand-drawn experiments and combined these with filmed abstract collages. The influence of Brakhage, McLaren and Lye continued in the digital age, where computer video editing technology allowed for extremely precise matching of sound to image. An excellent example of this is found in Michel Gondry's video for the Chemical Brother's *Star Guitar*, in which every sound in the piece is matched precisely with a visual object through complex compositing and video editing. [17] This form of extremely precise sound and moving picture mapping is the logical descendent of the initial experiments in synesthetic mapping made by Rimington and Scriabin a century previously.

It is worth mentioning that Fischinger, McLaren and Lye worked exclusively in a fixed film-based medium as opposed to the live performance medium of Rimington and Scriabin. Several artists did begin to work with real-time performed visuals in synchronization (or at least in tandem) with music performances. These were most notable in the 1960s and included various liquid light shows by The Joshua Light Show in support of acts such as Frank Zappa and the Mothers of Invention and Janis Joplin and The Kozmic Blues Band. For these shows they used a combination of liquids on overhead projectors improvised in rough synchronization with the live music. [18] These projections had much less precision than Lye's or McLaren's exact matching on film, but the did have the benefit of being live, real-time visual performances which could be adjusted or varied according to the needs of the music.

Other groups such as Single Wing Turquoise Bird also used film projection along with light shows in support of acts such as The Grateful Dead and The Velvet Underground. [19] The latter also famous collaborated with Andy Warhol to create the multimedia performance *The Exploding Plastic Inevitable* (1966-67), which included film projections, light shows and of course live music. The Single Wing Turquoise Bird's live visual setup was much more complex than that used by The Joshua Light Show "employing a vast array from powerful xenon projectors and color wheels to four-by-five slide projectors and strobe lights, all united by the performers into one multi-bodied Brobdingnagian robot reacting to the gyrating rhythm of the music." [20] This setup allowed for more precise matching of sound to image and enabled results in real-time that were closer to the exactitude of sound-image matching that Lye employed in his hand-drawn films.

Naturally there have been many other art forms that have referred to synesthesia as a key driving factor in the conceptualization and realization of artworks. These include the 'musical paintings' of Kandinsky, Hans Richter and others, the 'visual music' scores of composers such as Cornelius Cardew and John Cage, the visual music films of John Whitney and Larry Cuba, the experiments with digital video synthesizers in the 1970s and 80s and a range of computer-assisted performances and installations by artists such as Laurie Anderson: however, the conceptual and formal examples of synesthetic simulation found in Rimington and Scriabin's systems, as well as the animation and video work of McLaren, Lye and Gondry, and the live light and film shows of the Single Wing Turquoise Bird are most appropriate for our discussion.

## *VIRTUAL DJ* INTRODUCTION

"The original concept of *Virtual DJ* was to create a virtual room in which the audience could interact with sound and light by simply moving around with a motion-tracker in hand. With an acknowledgement to the obvious connections with the earlier [motion-activated audio] work of David Rokeby, [21] *Virtual DJ* is designed as a comparatively populist project, one in which the audience can interact in a very physical, almost aerobic manner to dance-oriented electronic music." [22]

"*Virtual DJ* uses two motion-trackers, one controlling drum and bass, and the second controlling melodies and samples." [23] Each tracker is assigned a light and when users move to a new sound zone, lights change in synch with their movements. The lights also follow the users around the room as they explore new sound and light combinations. This interaction model deliberately simulates the effect of synesthesia, as described above. *Virtual DJ* is organized in a series of five sound and light rooms, which become increasingly complex as the users move from room to room. Successive

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**Figure 2.** *Virtual DJ*, Steve Gibson, 2005. Stealth Attack Nottingham, Incubation 2005. Photo by Jonathan Griffiths. © Jonathan Griffiths, 2005. Used with permission.

rooms contain some materials related to earlier rooms (such as drum loops), but new audio and light materials and varied interaction models are introduced in each room in order to allow for a more complex and long-lasting experience.

### SIMULATING SYNESTHESIA IN *VIRTUAL DJ*

*Virtual DJ* uses robotic lights to produce light colors and effects in synch with sound objects and melodic materials. The synesthetic technique used is a mix of Rimington and Scriabin's ideas, but *Virtual DJ* also goes beyond what either of these artists conceived in matching light to sound. Unlike Scriabin (see Figure 1) *Virtual DJ* does not use a strict rule to govern the matching of light color to a specific tonality or note. The only rule that was established was that if a sound object was triggered successively then the same light color and effect would be predictably triggered in response to that object. This strategy makes it clear for users that they can repeat sound materials and they will always get the same light effect in response to their movements.

Despite the absence of a strict rule matching light to sound in *Virtual DJ,* an analogy can be made between Scriabin's technique of matching the color on the chromola with a change of tonality in *Prometheus*, and the technique of matching the light color/effect with a change of sound object that is used in *Virtual DJ*. Scriabin's idea is quite subtle compared to Rimington's one note / one color technique, which is perhaps best described as overly-obvious and has relatively limited potential for development. A change in tonality is a far more rich concept for a matched color change and speaks to a larger formal possibility for light/sound synesthesia. In addition, as stated above Scriabin's technique avoids the constant change of light color that Rimington's color organ produced (imagine a Bach Fugue of constant 16th notes played on Rimington's device!).

In relatively consistency with Scriabin's approach, in *Virtual DJ* sound objects such as drum loops and bass lines are assigned a light object. A user could chose to stay relatively motionless with a sound object and the light would remain on the same color and/or effect. The user can also move within the spatial coordinates assigned to a sound object (bounding spatial coordinates are called 'layers') and these movements would change audio and light parameters in synch with these movements, while keeping the basic sound and light objects present. Only when moving to a new spatial 'layer' would a new sound and light object be triggered (see the videos in Figures 3, 4 and 5 below for examples of this).

Sound and light in *Virtual DJ* are matched intuitively, and are based on the artist's subjective interpretation of what a specific sound object 'looks like.' Some melodies may appear and each note may be assigned a specific light color in the manner of Rimington (i.e one note / one colour), but this correspondence is only retained for the single melody itself, and the same notes in new melodies may be matched with entirely different light colors and/or effects. [24] In addition with robotic lights other effects than simple color are also available, extending the possibilities for light-sound synesthetic simulation beyond that of Rimington's color organ or Scriabin's chromola. Moving head robotic lights can act as followspots, automatically pointing to one specific user so she is aware that the light she is triggering is her own. In addition the lights used in *Virtual DJ* have rotation control, dimmer control, and two gobos for overlaying shapes on the lights. These effects are used formally to emphasize the matching of light to sound.

Figure 3 below shows how the user controls an arpeggiated melody with the first tracker. As the user moves forward the notes of melody go up in pitch. The melody is connected to a red light with a gobo applied. As the user moves forward the rotation of the gobo increases. Figure 4 shows how the user controls

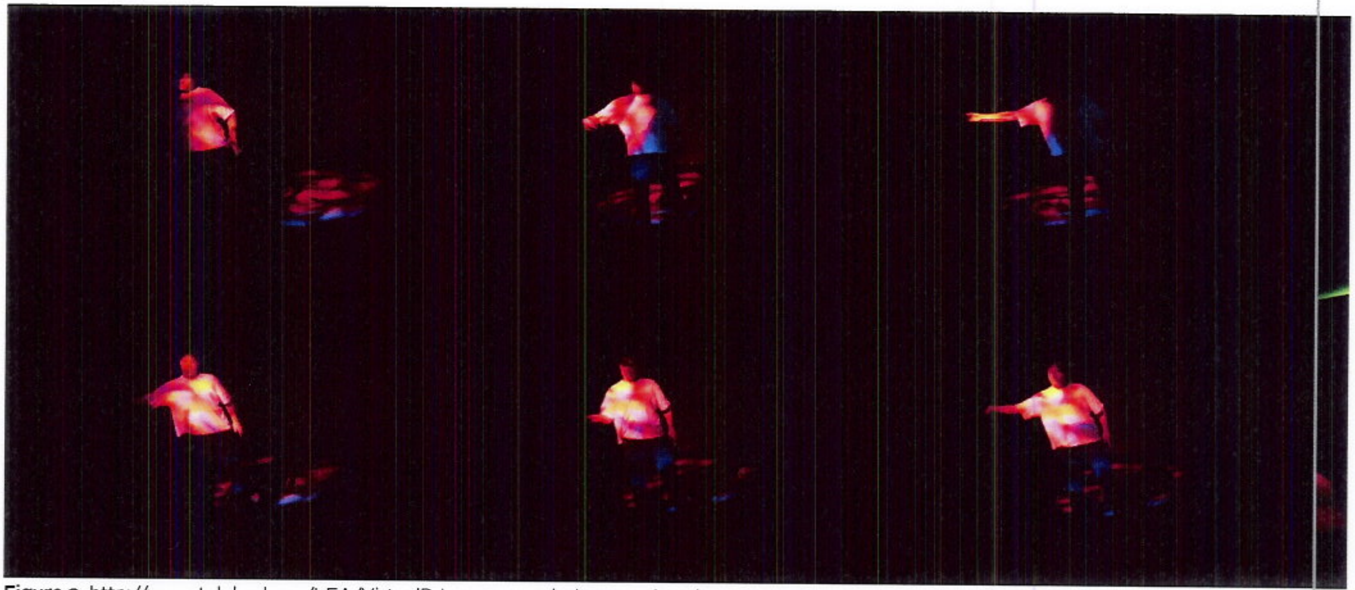

**Figure 3.** http://www.telebody.ws/LEA/VirtualDJ_room1_melody.mov, *Virtual DJ*, 2005, Steve Gibson, video documentation. Room 1 tracker 1 controlling a rising arpeggio and light gobo rotation with back and forth movement. © Steve Gibson, 2005. Used with permission.

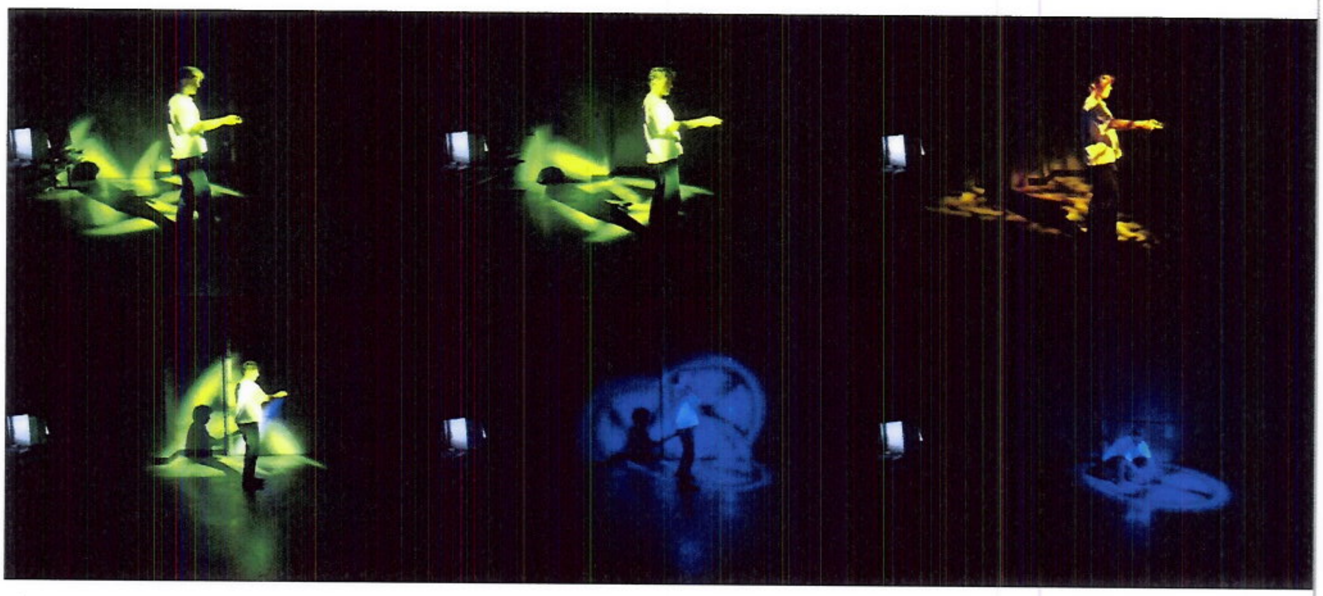

**Figure 4.** http://www.telebody.ws/LEA/VirtualDJ_room1_drumandbass.mov, *Virtual DJ*, Steve Gibson, 2005, Video documentation. Room 1 tracker 2 performed by Steve Gibson controlling a drum beat and bass lines, as well as the light dimmer and color with back and forth and side to side movements respectively. © Steve Gibson, 2005. Used with permission.

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a drum beat and bass line with a second tracker. As the user moves forward the drum beat and bass riff fade up in synch with an increase of the dimmer of a light. As he moves from side to side the bass line changes and this is matched in a change of light color and gobo. At the end the user goes down to the floor and the drum beat becomes more minimal while the light moves from a triple gobo to a single one, thus indicating the thinning of the musical texture.

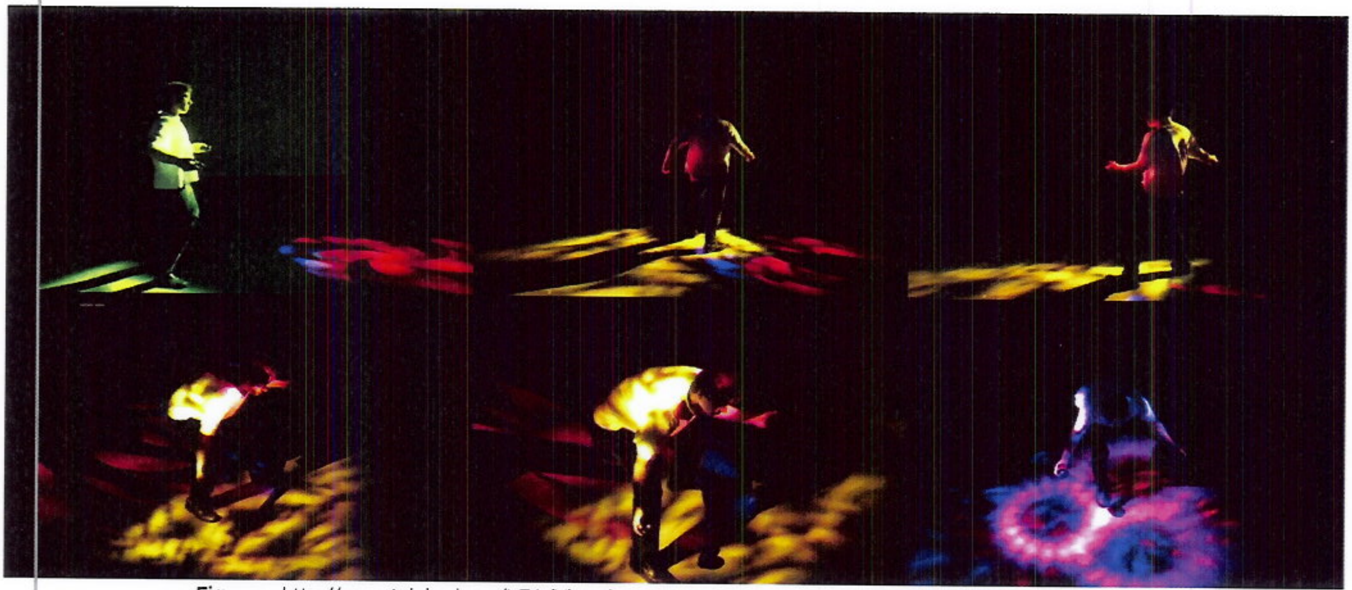

**Figure 5.** http://www.telebody.ws/LEA/VirtualDJ_room1_solo.mov, *Virtual DJ*, Steve Gibson, 2005, Video documentation. Room 1 performed by Steve Gibson with two trackers. © Steve Gibson, 2005. Used with permission.

Figure 5 above demonstrates how the elements of the two above videos can be controlled by one user with two trackers. In this example both melody and drum and bass as well as their corresponding lights are combined in real-time.

### *VIRTUAL DJ* MAPPING AND STRUCTURE

In *Virtual DJ* the 3D space has been mapped meticulously to allow users to have a satisfying interactive experience regardless of the style of their interaction. The spatial mapping of movement to sound and light was reworked based on the results from beta tests of hundreds of users over a two-three year period. These tests were both formal (i.e. measured beta tests in a controlled studio environment in which I wrote down user reactions and responses) and informal (i.e. resulting from a performance after which I arranged a follow up studio session with users). This helped to ensure the use of the synesthetic matching of light to sound was comprehensible in the first experience, but complex enough to warrant an extended experience in the environment.

As mentioned above, *Virtual DJ* is structured in five rooms of increasing complexity. Each room has its own character and varied synesthetic light-sound combination. The video except shown below in Figure 6 illustrates the complexity of the interaction in the final room five. Two performers control the environment, which by this point has multiple levels of interaction, including use of all three planes and measuring of user proximity. In each case though, the light and sound matching has been carefully established for each object. This keeps both the body-

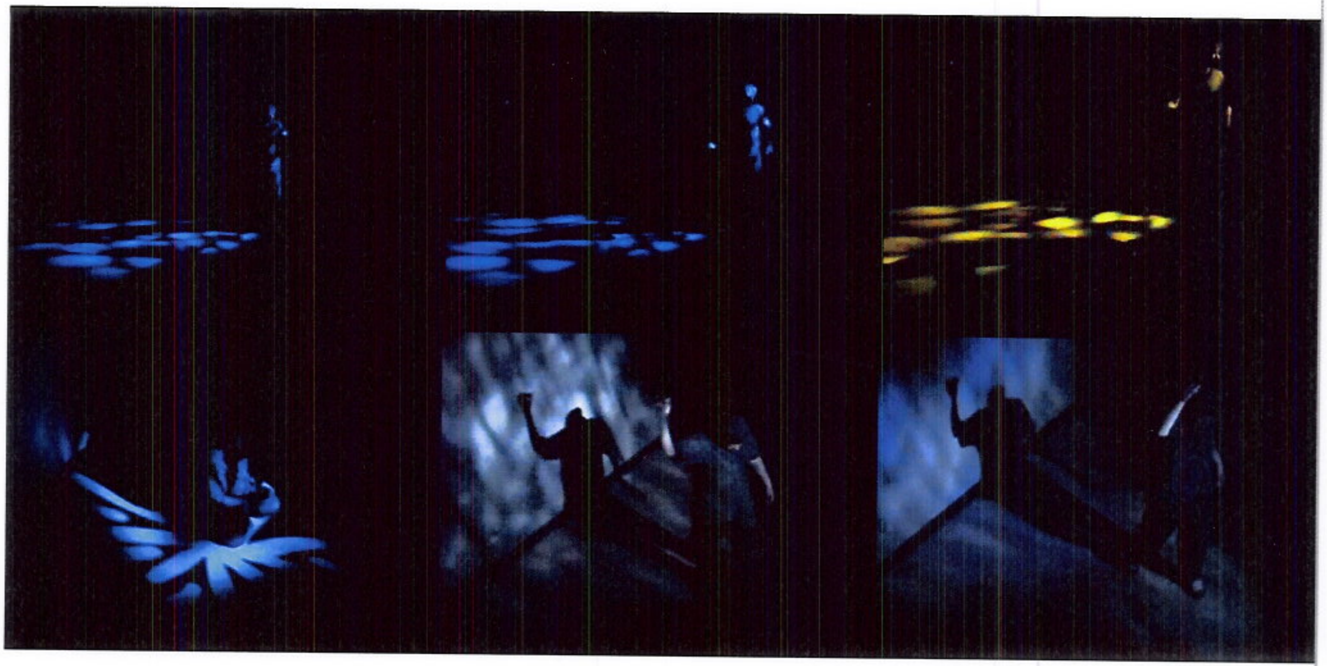

**Figure 6.** http://www.telebody.ws/LEA/VirtualDJ_room5_duet.mov,*Virtual DJ*, Steve Gibson, 2005. Video documentation. Room 5 performed by Steve Gibson and Jackson 2Bears. © Steve Gibson, 2005. Used with permission.

based interaction and the synesthetic matching of the mediums obvious enough to be directly understood by the users.

#### *VIRTUAL VJ* INTRODUCTION

The general concept of *Virtual VJ* is to allow two users to control different aspects of a sound and video environment with their body movements. As in *Virtual DJ*, two motion-trackers are used, but here one is set to trigger sound and video and the other is set to manipulate the sound and video initiated by the first tracker.

The key conceptual idea that is explored is the idea of cooperation and the sense of personal space in ephemeral, virtual systems. This is achieved by programming the trackers so that dramatic events will happen when the two trackers are close together or at a distance. For example the environment has been programmed so that the trackers apply distortion to the audio when they are proximate to each other and reverb when they are distant from each other. This results in a game of cat and mouse in which the users determine whether they will chose to closely follow the movements of the other participant or pursue a more individual experience.

The process for developing *Virtual VJ* began with the creation of audio materials, which were then programmed for interaction in 3D space and tested with user movements. Like *Virtual DJ* the audio was deliberately populist, consisting primarily of dance-based

**Figure 7.** *Virtual VJ*, Steve Gibson and Stefan Müller Arisona, 2011-12. Steve Gibson interacting with *Virtual VJ* at CHI 2011, Vancouver, Canada. Photo by Stefan Müller Arisona. © Stefan Müller Arisona, 2011. Used with permission.

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| Voice | Midi (Ch/CC) | Concept | OSC/DL Mapping |
|---|---|---|---|
| Master | CC 01/7 | Main Mixer Master | osc_master.in.value |
| Master Reverb | CC 02/101 | Control Glow | osc_master_reverb.in.value |
| Master Delay | CC 02/102 | Control Blur | osc_master_delay.in.value |
| Flanger Delay/Feedback | CC 07/91 | Control Footage Transform Speed | osc_flanger_delay.in.value |
| Kick Volume | CC 10/10 | Control Kick Circle(s) Brightness (B) | osc_kick_vol.in.value |
| Snare Volume | CC 10/12 | Control Snare Circles(s) B | osc_snare_vol.in.value |
| Hats Volume | CC 10/91 | Control Hats Circles(s) B | osc_hats_vol.in.value |
| Bass Volume | CC 10/5 | Control Base Footage B | osc_bass_vol.in.value |
| Bass Filter Frequency | CC 10/19 | Control Base Footage Min/Max/Sat | osc_bass_freq.in.value |
| Bass Distortion | CC 02/100 | Control Global / Local Distortion | osc_bass_distort.in.value |
| Loop Volume | CC 10/93 | Control KSH Circle Radius | osc_loop_vol.in.value |
| Loop, Kick, Snare, Hats Repeat | CC 02/103 | Control Flasher Active/Repetitions | osc_loop_repeat.in.value |
| Arpeggio Volume | CC 10/71 | Control Line Fetzer B | osc_arp_vol.in.value |
| Arpeggio Filter Frequency | CC 10/20 | Control Blur Zoom | osc_arp_freq.in.value |
| FX Volume | CC 10/84 | Control Footage Speed | osc_fx_vol.in.value |
| VOX Volume | CC 10/72 | Control Overlay Footage | osc_vox_vol.in.value |
| VOX Filter Frequency | CC 10/22 | Control Overlay Footage Min/Max | osc_vox_freq.in.value |
| Guitar Volume | CC 10/7 | Control Dave B | osc_guitar_vol.in.value |
| Vocoder Volume | CC 11/93 | Control Dave B | osc_vocoder_vol.in.value |
| Vocoder Filter Frequency | CC 11/91 | Control Dave Smooth | osc_vocoder_freq.in.value |
| Chords Volume | CC 10/30 | Control Dave B | osc_chords_vol.in.value |
| Chords Filter Frequency | CC 10/31 | Control Dave Transform | osc_chords_freq.in.value |
| Reason Cello Volume | CC 14/7 | Not used | osc_cello_vol.in.value |
| Reason Cello Filter Frequency | CC 13/74 | Control Base / Overlay Footage Shader | osc_cello_freq.in.value |
| Sample Volume | CC 16/7 | | osc_sample_vol.in.value |
| Sample 1 On | N 57 A3 | Footage 0 | osc_sample.in.channel.00.value |
| Sample 2 On | N 59 B3 | Footage 1 | osc_sample.in.channel.01.value |
| Sample 3 On | N 64 E4 | Footage 0 | osc_sample.in.channel.00.value |
| Sample 4 On | N 65 F4 | Footage 2 | osc_sample.in.channel.02.value |
| Sample 5 On | N 67 G4 | Footage 2 | osc_sample.in.channel.02.value |
| Sample 6 On | N 69 A4 | Footage 3 | osc_sample.in.channel.03.value |
| Sample 7 On | N 71 B4 | Footage 0 | osc_sample.in.channel.00.value |
| Sample 8 On | N 74 D5 | Footage 1 | osc_sample.in.channel.01.value |
| Sample 9 On | N 81 A5 | Footage 2 | osc_sample.in.channel.02.value |
| Sample 10 On | N 86 D6 | Footage 3 | osc_sample.in.channel.03.value |
| Room 1 | N 36 C2 | Switch to room | /valueset/vvj/room0/2/i |
| Room 2 | N 38 D2 | Switch to room | /valueset/vvj/room1/2/i |
| Room 3 | N 40 E2 | Switch to room | /valueset/vvj/room2/2/i |
| Room 4 | N 41 F2 | Switch to room | /valueset/vvj/room3/2/i |
| Room 5 | N 43 G2 | Switch to room | /valueset/vvj/room4/2/i |
| Room 6 | N 45 A2 | Switch to room | /valueset/vvj/room5/2/i |
| Room 7 | N 47 B2 | Switch to room | /valueset/vvj/room6/2/i |
| Room 8 | N 48 C3 | Switch to room | /valueset/vvj/room7/2/i |
| Room 9 | N 50 D3 | Switch to room | /valueset/vvj/room8/2/i |
| Room 0 | N 52 E3 | Switch to room | /valueset/vvj/room9/2/i |

**Figure 8.** This chart shows the mapping of music effect to MIDI data and then to visual data in the Soundium [25] VJ software. For example CC01/07 refers to MIDI channel 1, control number 7. The MIDI data is then programmed into the 3D tracking system so that users can continuously control sound and video parameters in synchronization and in real-time. © Stefan Müller Arisona, 2013. Used with permission.

electronica. The piece was initially developed with one motion tracker and then a second tracker was added as a manipulator of the data triggered by the first tracker. A series of nine rooms was established as the structure for the project and one tracker was assigned specific hotspots to allow for advancement to successive rooms. Following the development of user movement to audio control, a related series of controls was built for video manipulation so that seamless connections between the two mediums could be observed (i.e. music volume to image opacity). These controls were then mapped to 3D movements for simultaneous video control by user interaction. The video used in *Virtual VJ* is primarily abstract geometric shapes, with the occasional appearance of video samples that match audio samples from sci-fi films. In *Virtual VJ* there is a relatively (though not exclusively) fixed set of movements to audio and video controls and these are kept more constant than was used in *Virtual DJ.* See Figure 8 above for a precise list of MIDI mappings between the audio and video objects.

## SIMULATING SYNESTHESIA IN *VIRTUAL VJ*

While *Virtual DJ* is clearly descended from Rimington and Scriabin's color organs, *Virtual VJ* is more closely related to the experiments of Norman McLaren and Len Lye and the live projections used by Single Wing Turquoise Bird. While the matching of sound to moving image is not as exact as in McLaren's and Lye's work, the use of MIDI to trigger video files in precise synch with sound files recalls their work by establishing firm connections between the two mediums. The relatively reliability of MIDI allows these exact correspondences to be repeated faithfully with an reasonable expectation that once a mapping between a sound and video file is established this will remain fixed. As in *Virtual DJ* each sound object is assigned a visual object, but in *Virtual VJ* these visual objects are not lights but video files. In addition digital-signal processing (DSP) is employed in the live video software Soundium. DSP is conventionally used to cause a visual environment to react to audio in some way. We use this to cause the video files to bounce in synch with the incoming audio signal.

The addition of real-time control over sound and visual parameters extends *Virtual VJ* beyond the possibilities available in Lye's and McLaren's fixed film-based work and recalls the live visual work of Single Wing Turquoise Bird and others in the 1960s and 70s. However, with the use of precise computer-based MIDI mapping the process is more precise than could be achieved in the Single Wing Turquoise Bird's analog performances. *Virtual VJ* does retain some of the improvisational possibilities of the 1960s live visual events nonetheless: as the sound and video materials are triggered and manipulated in real-time by body motion, participants can choose to re-assemble the audio-visual materials as they see fit. While there are a limited set of sound and video objects and real-time controls, these are sufficient enough to ensure each new 'performance' will be different from the previous one.

The video in Figure 10 on the right shows one performer controlling both the audio and video in realtime. In this example the bass line is connected with

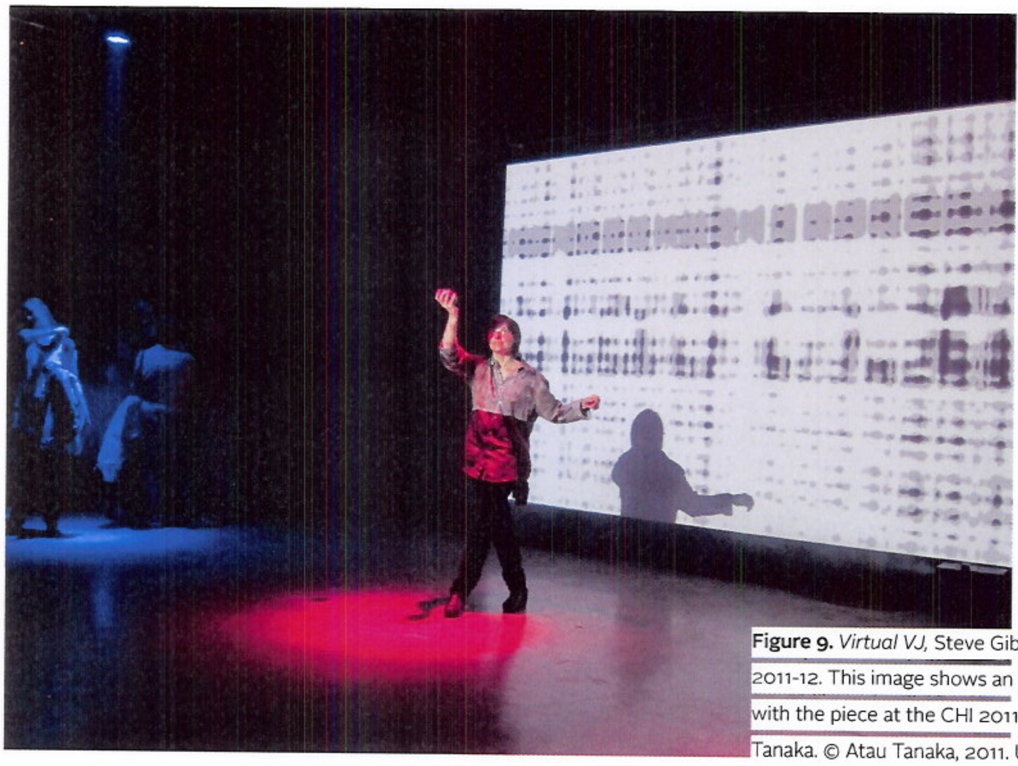

**Figure 9.** *Virtual VJ*, Steve Gibson and Stefan Müller Arisona, 2011-12. This image shows an audience member interacting with the piece at the CHI 2011, Vancouver. Photo by Atau Tanaka. © Atau Tanaka, 2011. Used with permission.

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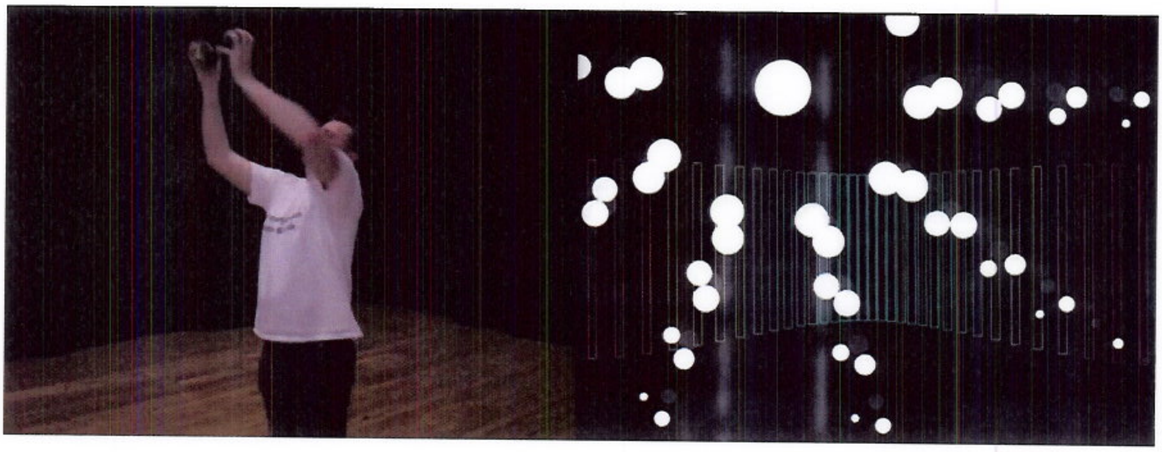

**Figure 10.** http://www.telebody.ws/LEA/Virtual_VJ_Solo_Room1.mov, *Virtual VJ*, Steve Gibson and Stefan Müller Arisona, 2011-12, video documentation. Performed by Steve Gibson. Video shot by David Green and edited by Steve Gibson. © Steve Gibson and Stefan Müller Arisona, 2012. Used with permission.

an abstract video of vertical and horizontal lines at the start. When the drums are triggered a geometric pattern of circles is invoked and when the performer lifts his hand past his shoulders a multi-coloured series of vertical lines is triggered in synch with a guitar riff. As the performer brings the two trackers into proximity with each other, distortion is applied to bass track along with video zoom. Finally when the user approaches the screen a new room is triggered, instantiating new audio and video files.

The following video in Figure 11 shows the same materials as in Figure 10 but in this example there are two performers: a dancer using the tracker that triggers audio and video, and the artist manipulating audio and video parameters. Note that in this video when the performers are distant from each other reverb is applied creating a more 'distant' audio mix. Glow is simultaneously applied to the video track with this performer distance, therefore reinforcing the synesthetic connection between audio and video materials.

The following two videos illustrate the interaction methods in *Virtual VJ* in more detail. In the solo example in Figure 12 the performer triggers the visuals and audio with tracker one in his right hand and he manipulates aspects of both with tracker two in his left hand. As in the above examples, distortion is applied to the bass when the trackers are proximate. When the performer drops to the floor with tracker one, speech samples from sci-fi films are triggered along with corresponding clips from the same films.

**Figure 11.** http://www.telebody.ws/LEA/Virtual_VJ_Duet_Room1.mov, *Virtual VJ*, Steve Gibson and Stefan Müller Arisona, 2011-12, video documentation. Performed by Olivia Hayes and Steve Gibson. Video shot by David Green and edited by Steve Gibson. © Steve Gibson and Stefan Müller Arisona, 2012. Used with permission.

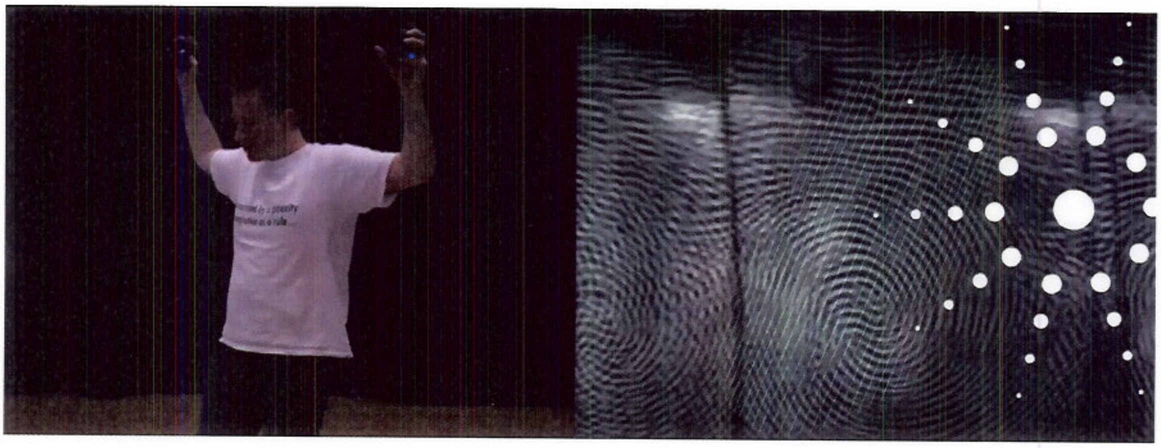

Figure 12. http://www.telebody.ws/LEA/Virtual_VJ_Solo_Room4_6.mov, *Virtual VJ,* Steve Gibson and Stefan Müller Arisona, 2011-12. Video documentation. Performed by Steve Gibson. Video shot by David Green and edited by Steve Gibson. © Steve Gibson and Stefan Müller Arisona, 2012. Used with permission.

When he lifts tracker one up high (past 150 cm) new melodies are triggered. By using velocity (i.e. speed of movement) in tracker two, the performer can apply delay to the speech samples or to the melody, along with blur to the videos. By moving to alternating ends of the room he can load new rooms. In Figure 12 he passes through three distinct rooms, though it should be noted that some of the AV materials are the same, similar or related between each room. In each succeeding room the interaction design employed is the same, with no drums on the floor, distortion applied to the bass with tracker proximity, etc.

In Figure 13, the same AV materials used in Figure 12 are now controlled by two performers. This results in a more 'game-like' performance than the solo performance, with the users cooperating at points and diverging at others.

## OPTO-PHONO-KIENSIA, A NEW TYPE OF SYNESTHESIA?

According to the classification system used by the Mixed Signals website there are an enormous number of possible variations of synesthetic experience. The site uses words of Greek origin to describe these different subtleties. For example 'optophono' synesthesia refers to the experience of sight in relation to sound and 'kinesichromia' refers to the experience of color in relation to movement. [26] Extrapolating from this we could posit a type of synesthesia called 'optophono-

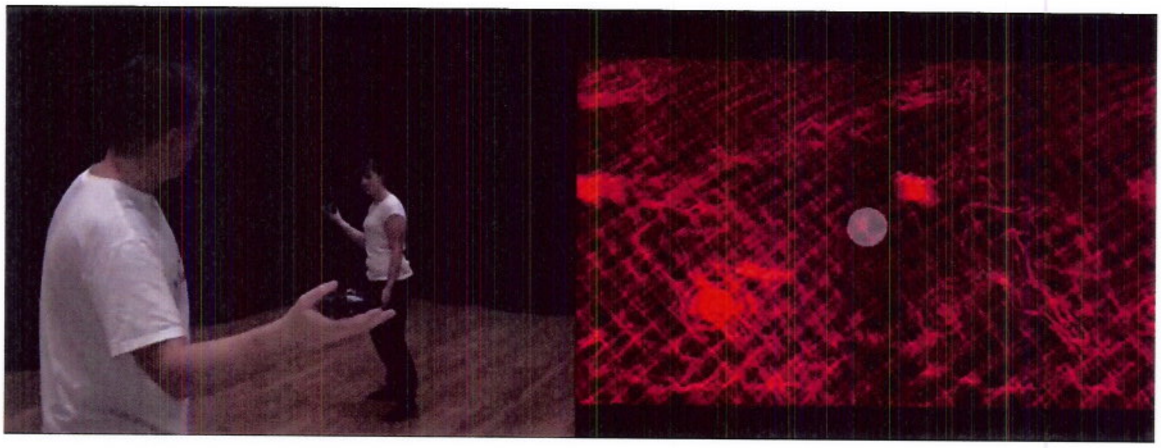

Figure 13. http://www.telebody.ws/LEA/Virtual_VJ_Duet_Room4_7.mov, *Virtual VJ,* Steve Gibson and Stefan Müller Arisona, 2011-12. Video documentation. Performed by Olivia Hayes and Steve Gibson. Video shot by David Green and edited by Steve Gibson. © Steve Gibson and Stefan Müller Arisona, 2012. Used with permission.

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**Figure 14.** *Virtual VJ*, Steve Gibson and Stefan Müller Arisona, 2011-12. Jade Valley Winery, Xi'an China, August 2011. The image shows the performance by Steve Gibson, with the video projected on a large wall surface at the winery. Photo by Zheng Wang. © Zheng Wang, 2011. Used with permission.

kinesia' which would refer to the experience of sight and sound in relation to movement. While I have not come upon any synesthetes in my research who possess the exact condition of 'optophonokinesia,' it is theoretically possible. Despite this lack of a confirmed 'real' model, what users experience in both *Virtual DJ* and *Virtual VJ* is in effect a simulation of 'optophonokinesia' in which their movements in 3D space activate simultaneous audio and visual stimuli. Subjective descriptions of both environments have generally defined the experience as one in which 3D space has tactility. When a light is instantiated in synch with a sound as one enters a spatial zone it feels as if that zone has some kind of weight, presence or boundary, confirming at least anecdotally that the simulation of 'optophonokinesia' has been in part successful.

## ENABLING SUBJECTIVE USER INTERACTION THROUGH REDUNDANCY

Both *Virtual DJ* and *Virtual VJ* are based on the basic interface design strategy of using redundancy to enhance immediate user interaction. In effect this is how the synesthetic simulation is achieved in these pieces. In addition this is what allows users to have an easier understanding of how their spatial movements are affecting the environment. In short the synesthetic connection between the mediums of movement, sight and sound is what creates the user interface design strategy in *Virtual DJ* and *Virtual VJ*.

In common usage, redundancy is often thought of a negative term, but in computer-controlled environments the use of redundant information in an interface design can often lead to greater user clarity, particularly when the information between mediums is sufficiently obvious. In *Virtual DJ* lights and sound are matched very precisely. When a user perceives a change in sound due to a movement, the lights will change in a similar manner. This redundant information over the two mediums allows users to experience a more tactile sense of space and to more easily infer how their interactions are affecting the audio-visual environment. In *Virtual VJ* the redundant information is passed between the audio and video realms in a similar manner to *Virtual DJ*.

Similarly both environments have been mapped in a way that allows them to produce a predictable result (i.e in *Virtual VJ* raising the hands will generally produce a rise in audio volume and an increase in image opacity). At the same time users are free to roam wherever they wish, to combine audio and visuals in whatever manner they chose. This predictability is in fact an asset in that it allows users to lose their self-consciousness when interacting: they do not fear playing 'wrong notes.' This is in opposition to many similar environments in which users are often mystified by the interaction model due to a lack of spatial planning or an over-complex interaction model. On the other hand the spatial mapping in both *Virtual DJ* and *Virtual VJ* is quite complex; in many rooms several parameters can be changed simultaneously by different motions; however, because the changes are logically mapped to movements and the results are predictable and repeatable, users gain a sense of control that they would not otherwise have in more 'randomly' mapped spatial environments.

## CONCLUSION

This paper has argued for synesthetic simulation as a way for artists to generally invoke meaning and a correspondence between the audio and visual realms. It has also posited that within 3D motion-based environments the simulation of the cross-modal condition of synesthesia can be an asset when planning for complex user interaction in 3D space. This interface design model could be extended to different types of environments where cross-modality is used, for example in tactile touch-based interfaces which employ simultaneous media control of audio, video, text and other forms.

Using a combination of motion-tracking with matched live video, light and sound the artist can create the illusion of 'optophonokinesetic' synesthesia for participants and viewers. Beyond being a mere technique for creating a hollow spectacle, this tactic can in fact enhance user meaning, helping participants to interact with a 3D environment with more confidence, and producing more satisfying results for both the users and the spectators. Users can intuit spatial interaction interfaces more effectively with redundant information programmed between the different mediums. This assists with creating meaningful interactivity in the unfamiliar medium of 3D spatial environments, and helps establish formal and aesthetic meaning for the audience, while simultaneously avoiding the pitfalls of random and over-complex interface design and programming. ■


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For further information on *Virtual DJ* and *Virtual VJ*, including documentation, please see http://www.telebody.ws/VirtualDJ

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